were described from those of the female flower: the bractea, present in both, has been completely passed over; the calyx of the male is stated to be three-parted, while it is six-parted; and the pubescence, which is present in the calyx of both sexes, has been likewise omitted; the bractea is likewise covered with hair.

River Quitaro, Lat. 2°. 50′. N., November 1837.

XXIX.—*On the Root of the Madder.* By M. Decaisne.

In the valuable 'Recherches Anatomiques et Physiologiques sur la Garance,' lately published at Paris by M. Decaisne, that gentleman gives the following interesting account of the root.

The roots of the Madder or Turkey red (*Rubia tinctorum*) are of the form generally described as a *branching root,* for though undivided when young, they shortly begin to ramify, though the original shoot remains the thickest; their anatomy, which I shall proceed in few words to describe and trace through its several stages of growth, will explain their structure.

During the first days of germination, and while the plant has no other leaves than its two cotyledons, the root is simple and unbranched; its upper part, immediately below the neck, being covered with very slender fibrillæ, which closely clasp the grains of sand with which they may come in contact. If the young root be cut horizontally across at this part, it will be seen to consist, looking from the circumference to the centre, of, first, a row of extremely small cortical cells, some of which emit externally a very fine and simple prolongation, constituting the above-mentioned fibrillæ, in the same way as the epidermal tissue of leaves gives rise to hairs. After this row of cortical cells comes a thicker or thinner layer of cellular tissue, whose divisions diminish in size as they approach the centre, while the innermost part is almost confounded with the fibrous tissue which surrounds the vessels occupying the whole middle of the root. The vertical section of a young rootlet (if it may be so termed) exhibits the cortical cells arranged in nearly regular longitudinal series, slenderer than the others; then those which compose the fleshy portion in series which become more and more regular as they advance further towards the fibrous tissue, which latter is formed of more elongated cells arranged with equal regularity. It is in this fibrous part that, more generally than elsewhere, we find cells containing crystals as well as the vessels of the latex; the latter, which I have only been able to detect in a single instance and by means of maceration, appeared to me flattened, and with swellings at regular distances. As regards the cellules which form the fibrous tissue, these are seen to be elongated and to terminate in a blunt apex; they are transparent, and have thicker partitions than those of the cellular tissue which contain the green matter, and are closely applied to one another.

The centre of the root is almost entirely formed of vessels; if examined at the same stage as in the preceding observations, these vessels will appear under the form of transparent elongated cells, generally placed end to end, and forming by their combination a sort of cylinder, placed in the centre of annulated vessels which are separated by long intervals from each other, and surrounded for its entire length by the cellular and fibrous layers formerly described; it extends a little further and below these, forming a slight projection which constitutes the *spongiole*.

In this incomplete state of organization these vessels seem to perform an office similar to that of the cellular tissue or medulla. Later, and when they have attained their perfect organization, instead of being thin and transparent, they present (on examining, when highly magnified, their horizontal section) many divisions, which are of a brighter or paler fawn colour, and in which I could clearly distinguish the cavities to which MM. De Mirbel and Hugo Mohl have lately called the attention of the curious. These belong to what are termed *punctuated vessels*, and are of uncertain diameter, with empty spaces between them. These hollow spaces or intervasculary meata contain a colouring matter analogous to that of the cellular tissue; and it is probable that the *madder powder*, furnished by the central or vascular part of the root, only owes its superior quality over what is obtained from the cellular tissue, (or alburnum of the manufacturers,) to the entire absence of all foreign substances. In fact, I never observed any crystals among the vessels, and this is the only difference I have been able to detect between the parts of the two tissues containing the colouring principle. However, the woody part, completely stripped of the surrounding cellular tissues, affords the very finest powders, according to the observations of the manufacturers in the South of France; these remarks contradicting those of M. E. Kœchlin, as will be shortly seen. I ought to state that I have cut through these vessels at different periods of growth, and never found them filled with liquid. It is they which appear, in an early stage, to produce the radicles; in fact, when examining young roots, I have often seen, after removing the cellular tissue by maceration, that the ligneous body formed of the vessels I have described, has emitted from its circumference projections more or less apparent, which afterwards by elongation produce the radicles which are already noticed.

If the root be again scrutinized when far more advanced, still its internal structure will appear to have undergone no material change, and the organization which I have described is found to be the same; the only appreciable difference consisting in a proportionate increase of the tissues, whose several layers are thickened by the addition of new rows.

The *madder root,* which was pale yellow at the earliest period of its developing, gradually acquires a deeper and deeper tinge, as takes place in age with the several parts of almost all vegetables. The same phænomenon exists in the cotyledons; for if a section of the infant stalk be made at the period when it first bursts from the seed, the cotyledons will be seen to emit a yellowish fluid, which shortly assumes a decidedly red hue.

By the above facts, it may be ascertained that, so far as depends on the arrangement of the different parts, the *root of madder* departs in no respect from the common structure of roots. No peculiar cavities, designated by the name of *reservoirs for the proper juices,* seem to exist. If the fluid which the vessels of the latex contain were in any respect unlike that which is observable in all the cells, it can be only in the fainter colour, since these are with difficulty discerned; and as to the existence of crystals in some of the cells, this is by no means an extraordinary circumstance, as they may be frequently found in other plants.

It remains for us to see what are the phænomena that take place in the fluid that is diffused through the whole cellular tissue of the root. It has been already remarked, that the roots, which, when very young, are pale yellow, assume a much deeper hue when old. If this fluid be carefully examined, it will not appear to hold any substance in solution; and whether it escapes through the partitions of the cells or by an incision purposely made, it still seems perfectly limpid. As, however, when the root is thoroughly dried, the internal cells, though all the fluid has evaporated, still assume a yellow tint if laid to steep, it would appear that the liquid had originally possessed a solid colouring principle, though, even in this state, such is its tenuity, that the largest swellings do not allow it to be seen.

It is of course presumed in the above observations, that the different parts have been subjected to no external agency whatever, as such agency produces great changes; for instance, after having made sections, whether vertical or horizontal, of a young root, and subjected them to microscopical examination, this juice, which is so perfectly limpid in the living plant, presently becomes thick and cloudy, while its originally pale yellow tint changes to a bright rose colour. Experiments on older roots yield the same results, except that as in these cases the yellow fluid is originally much brighter, so its change to red when exposed to the air becomes proportionably intense, and instead of acquiring, as in the preceding case, a roseate tint, the result, from an orange colour, is a change to the most vivid red.

If attention be paid to the circumstances under which this red colour is obtained, which did not exist before the section of the parts, we cannot but suspect that the action of the air, which was previously excluded, is the cause more or less of this change, and an increased number of experiments confirms this opinion. In a thin layer the modifications occasioned by the external air on the yellow colour may be successively traced; the red tinge always manifesting itself first in that part of the cellular tissue contiguous to the vessels of the latex; next in the cells occupying the intervals of the dotted vessels in the centre of the root; and lastly in the various parts of the cellular tissue which compose the fleshy portion, and which is the principal deposit of the yellow fluid.

It is easy to understand these phænomena in a thin layer of root, and to explain the production of the red hue in these determinate places; the air passes most freely, and consequently with the greatest rapidity, into the part filled with vessels, the cutting open of which, at both ends, makes a free way for it, and where it meets with no obstruction from the transverse diaphragms that exist in the cellular tissue. The proper vessels situated immediately next to these, and habitually replete with liquid, and protected with very thin *parietes* through which any gas can readily take effect, will be the first to become coloured, as well as the spaces comprised between these vessels and those to which I formerly alluded; while, lastly, the cellular tissue being composed of numerous superincumbent cellules, and thus offering many impediments to the action of the air, it is easy to perceive that the most external cellules will first receive its influence, and that in the intermediate layers there will be portions on which it can only act after a longer or shorter time, and of which the colour will consequently remain yellow while the cellules around have assumed a red colour. Those cells which lie on the thin edges of the section are always first tinged, evidently because the air affects them first. It is practicable too to alter at will the hue of one or more cells, to effect which it suffices to remove a thin slice from a previously dried root, some cells remaining uninjured; then, if with great precaution certain cells be punctured with a curved point, so as to admit the entrance of the air, the yellow fluid with which they are filled will be seen to pass instantly to red. I have also placed some sections of *madder root* in water which had been exhausted of air by the operation of boiling, and in this case their originally yellow hue remained entirely unaltered, the utmost care having been previously taken to keep these sections of root in tightly closed bottles, without which they redden slightly.

I have tried the action of different gases collected in graduated tubes plunged in the mercury, in which I deposited thin segments of fresh *madder root* cut both vertically and horizontally, and they remained there eight days without exhibiting the slightest change of hue. But when by means of a blow pipe I introduced a few drops of water into the tube of oxygen gas, the red colour was instantly produced. Carbonic acid gas did not appear to me to exhibit the same peculiarities; and certainly the oxygenated water, whether applied to the roots in a fresh or dry state, failed to effect the change to red at all more quickly than as much common water would have done.

Thin slices of young roots, when exposed for some hours to the air, after undergoing the customary transitions of tint, often acquire a blackish or violet hue which is not observable in old roots.

From all that has been stated, it results that the *madder root*, when living, has no colour but yellow, and that this colouring principle only varies by the deepening intensity of age. These different degrees of intensity are represented in the series of drawings, where I have represented the variation of hue in the roots from the young to the old state. This observation is easily verified; nothing more is necessary than to break two roots of different ages and to watch the change of hue from that instant till the air begins to take effect; the fluid will then be seen to be perfectly transparent while inclosed in the cells, but shortly this pellucid and pure liquid will become muddy and granulated so as to darken the parts of the cells with which it comes in contact. These granules, which seem to me to partake of the nature of gum resins, are partly soluble in alcohol; but as the dye of iodine fails to impart to them a blue colour, they do not show any identity with feculum. Their diameter is nearly equal, but they are inappreciable except in a mass, when insulated being hardly visible, as even with the aid of an excellent microscope divided in 300dths of millimetres, it was impracticable, by reason of their tenuity, to measure them precisely.

The *madder roots* many years old contain no coloured parts except what I have now pointed out, whether the plant be examined dry or after the exsiccated portions have been subjected to maceration. The existence of a yellow colour is all that I have been able to ascertain, and the simple yet striking fact of the absence of the red colouring principle until the root has been pulverized, seems to have been unknown to the present day.

Still this observation, originally made by M. Chevreul, is stated in a paper by M. Kœchlin, inserted in the Bulletins de la Société de Mulhausen, vol. i. No. 3, in the following words: "By compressing the fleshy part of the fresh root an acid liquid is obtained, which, originally yellow, turns red when exposed to the air. This liquid, applied to a cloth that has received the mordant of acetate of alumina, produces a bright red, which by soap changes to a dullish rose. It tinges ammonia purple and concentrated sulphuric acid red, and an addition of water to the tinged acid precipitates the colouring substance. These experiments seem to prove that the colouring substance is in a state of solution in this fluid.

"The stalk of *madder* and its root, whether whole or the woody and fleshy parts individually, have been used to dye samples of the same size and printed with mordants red, pink, violet and black, and the result is that the fleshy part contains almost exclusively the colouring substance, the woody portion possessing no more of it than do the stalks of this plant.

"These various parts of the *madder*, when used fresh, have invariably produced much richer hues than the same parts if previously dried, although this process of desiccation had not diminished their weight. And however numerous were the experiments, their result was always the same.

"When the root is examined with the microscope, no trace of separate colouring substance is discernible; the woody part is very porous, as in all vegetables; and the fleshy portion seems composed of mucilaginous liquid parts, inclosed in a net-work of woody filaments, without offering any trace of porosity.

"The '*Alizaris*' of Avignon are composed of stems and roots; the former having been covered up with earth, assume the appearance of roots without acquiring their dyeing virtues, so that the cultivator who thus increases the quantity of his produce materially lessens its value. For these stems, containing very little colouring principle, this plan only tends to adulterate the *madder*, of which the quality thus depends on the greater or less quantity of stem that had been buried and is now gathered and sold with the root."

The authors who have most fully treated this subject, however, regard the roots as imbued with a red colour while growing, and undergoing no change in this respect from subsequent circumstances. Many manufacturers, ignorant of this fact, to whom I submitted my observations, and showed the roots passing through all the stages of colour up to that which they attain when reduced to powder, while they formerly exhibited no trace of a red hue, have positively assured me that this remark would certainly lead to modifications in their manufacture. The assumption of a red colour is therefore a chemical phænomenon quite independent of vitality, while the yellow hue, on the contrary, seems to arise from a vital action which forbids the first; thus, if I place, for comparison, two portions of root, one living and the other dried, in a bottle, the former will preserve its yellow hue, while the second turns red, and in two days ends by acquiring a violet tinge.

Finally, the better to establish the vital power of the cells, and to prove that the production of the colouring principle was entirely determined by their peculiar action, I caused two young *madder plants* to germinate in distilled water; they grew very little, but the tissue of their roots notwithstanding secreted a yellow fluid, the tint of which seemed to me quite as decided as in young plants of equal size raised in earth. This colouring therefore depends on a peculiar action of the cellular membranes, to solve which it would be necessary first to solve that hitherto inscrutable problem of the vital powers*.

XXX.—*Catalogue of the Slender-tongued Saurians, with Descriptions of many new Genera and Species.* By JOHN EDWARD GRAY, Esq., F.R.S., Senior Assistant in the Zoological Department of the British Museum, &c.

THE Saurian reptiles may be divided into two nearly equal groups; one having a short, thick, slightly-nicked papillary tongue, and the other a more or less elongated forked tongue.

* [We shall reserve the author's analysis of the stems for a future Number of the Annals.—EDIT.]